The NASA SCI Files™
The Case of the
Wacky Water Cycle

Segment 3

As Jacob continues searching for water with his divining rods, the tree house detectives seek assistance from Dr. Adamec at NASA's Goddard Space Flight Center. Dr. Adamac helps the detectives better understand weather and climate and introduces them to the concept of El Niño. Meanwhile, the detectives once more contact Corrine, a member of the NASA SCI Files™ Kids' Club, to meet with Dr. D at Hoover Dam in Arizona to learn more about alternative sources of water. Dr. D suggests that the tree house detectives contact Mr. Ken Herd at the new desalination plant in Tampa Bay, Florida. After some creative brainstorming, the detectives wade even deeper into their wacky water problem.

Objectives

The students will

- demonstrate the movement of ocean currents.
- build a reservoir and water distribution system.
- identify the watershed that serves a local community.
- explain the process of desalination.
- build a solar water still.
- demonstrate the concept of parts per million.

Vocabulary

desalination – the process of removing salts from saltwater to make freshwater

El Niño – the most powerful weather phenomenon on the Earth that alters the climate across more than half the planet; this recurring set of climate conditions is linked to unusually warm water in the central Pacific Ocean

La Niña – a recurring set of climate conditions linked with unusually cold water in the central Pacific Ocean

osmosis – the passage of material, such as a solvent, through a membrane, such as a plant or animal cell, that will not allow all kinds of molecules to pass

NOAA – National Oceanic and Atmospheric Administration; a federal agency that monitors weather in the United States

reverse osmosis – the mechanical process in which solutions are forced through semipermeable membranes under high pressure

satellite – a heavenly body orbiting another larger one; any object put into orbit around Earth or any other planet to relay signals or transmit scientific data

semipermeable – a membrane or tissue that allows some types of particles to pass through, but not others

upwelling – the rising to the surface of deeper, cooler layers of ocean water that are often rich in nourishing substances

watershed - the land area that drains into a particular lake, river, or ocean

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 3 of *The Case of the Wacky Water Cycle*, discuss the previous segments to review the problem and assess what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA SCI Files™ web site and have students use it to sort the information learned so far.
2. Review the list of questions and issues that the students created prior to viewing Segment 2 and determine which, if any, were answered in the video or in the students' own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 2. Use tools located on the Web, as was previously mentioned in Segment 1.
4. Focus Questions — Print the questions from the Educator's Area of the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the program so they will be able to answer the questions. An icon will appear when the answer is near.
5. What's Up? Questions — Questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. These questions can be printed from the Educator's Area of the web site ahead of time for students to copy into their science journals.

View Segment 3 of the Video

For optimal educational benefit, view *The Case of the Wacky Water Cycle* in 15-minute segments and not in its entirety. If you are viewing a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Have students work in small groups or as a class to discuss and list what new information they have learned about the water cycle, climate, and alternative sources of water. Organize the information, place it on the Problem Board, and determine if any of the students' questions from Segment 2 were answered.
4. Decide what additional information is needed for the tree house detectives to determine what may have caused a significant drop in the water level. Have students conduct independent research or provide students with information as needed. Visit the NASA SCI Files™ web site for an additional list of resources for both students and educators.
5. Choose activities from the educator guide and web site to reinforce concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid student understanding in those areas.
6. For related activities from previous programs, download the Educator Guide for *The Case of the Phenomenal Weather*. Visit the home page and click on the fence post that says "Guides." Click on "2001–2002 Season". Scroll down and click on either the full guide or a segment of the guide for *The Case of the Phenomenal Weather*. In the guide you will find the following:
   a. **Segment 3** – 3-2-1 Blast Off!
   b. **Segment 4** – NASA Needs Help
7. If you did not have time to begin the web activity at the conclusion of Segments 1 or 2, refer to number 6 under "After Viewing" on page (16) and begin the Problem-Based Learning (PBL) activity on the NASA SCI Files™ web site. If the web activity was begun, monitor students as they research within their selected roles, review criteria as needed, and encourage the use of the following portions of the online, PBL activity:

   Research Rack — books, internet sites, and research tools

   Problem-Solving Tools — tools and strategies to help guide the problem-solving process

   Dr. D's Lab — interactive activities and simulations

   Media Zone — interviews with experts from this program

   Expert's Corner — listing of "Ask-An-Expert" sites and biographies of experts featured in the broadcast
8. Have students write in their journals what they have learned from this segment and from their own experimentation and research. If needed, give students specific questions to reflect upon as suggested on the PBL Facilitator Prompting Questions instructional tool found in the educator's area of the web site.
9. Continue to assess the students' learning, as appropriate, by using their journal writings, problem logs, scientific investigation logs, and other tools that can be found on the web site. Visit the Research Rack in the tree house, the online PBL investigation main menu section, "Problem-Solving Tools," and the "Tools" section of the educator's area for more assessment ideas and tools.

Careers

engineer
marine biologist
marine geologist
oceanographer
water treatment plant operator

Resources

Books

Arnold, Caroline: *El Niño*. Clarion Books, 1998, ISBN: 0395776023

Breen, Mark: *Kid's Book of Weather Forecasting*. Williamson Publishing, 2000, ISBN: 1885593392.

Locker, Thomas: *Where the River Begins*. Penguin Putnam, 1993, ISBN: 0140545956.

Niesen, Thomas M.: *Marine Biology Coloring Book.* Harperinformation, 2000, ISBN: 006273718X.

Rose, Sally: *El Niño and La Niña*. Simon & Schuster, 1999, ISBN: 0689820151.

Sayre, April Pulley: *El Niño and La Niña: Weather in the Headlines*. Millbrook Press, 2000, ISBN: 0761314059.

Seibert, Patricia: *Discovering El Niño: How Fable and Fact Together Help Explain the Weather.* Millbrook Press, 1999, ISBN: 0761312730.

Singer, Marilyn: *On the Same Day in March*. Harper Collins, 2000, ISBN: 0-06443528-8.

Trueit, Trudi Strain: *The Water Cycle*. Scholastic Library, 2002, ISBN: 0531119726.

Williams, Jack: *The Weather Book*. Random House, 1997, ISBN: 0679776656.

Web Sites

EPA—Surf Your Watershed
Use this site to locate and learn about the watershed where you live. The site includes links to real time stream flow maps, fact sheets, and watershed quizzes.
http://www.epa.gov/surf2

Dateline: El Niño
Dateline: El Niño is an interdisciplinary weather lesson where students can take on the role of a reporter who must find out why the weather has been so strange in their area. Students visit other sites for graphics and real time data regarding this weather phenomenon.
http://weathereye.kgan.com/expert/nino/index.html

NOVA—Water Temperature Graphics
Watch the water temperature change week to week in this graphic from Nova.
http://www.pbs.org/wgbh/nova/elnino/anatomy/warmwater.html

Visit to an Ocean Planet
This web site includes extensive educational activities, in PDF format, provided by various educational organizations and educators as part of the Visit to an Ocean Planet CD-ROM. The free CD may be ordered from NASA.
http://topex-www.jpl.nasa.gov/education/activities.html

NOAA—Climate Division Drought Graphics
Use this web site to generate graphs to show temperature, precipitation, or drought indices for any region in the United States.
http://lwf.ncdc.noaa.gov/oa/climate/onlineprod/drought/xmgrg3.html

World Climates
Look at different climates of the world. Use the Koeppen Classification System to determine how climates are defined. Maps included.
http://www.blueplanetbiomes.org/climate.htm

Brookfield Zoo's Biome Game
Play this exciting game, In Search of the Ways of Knowing Trail, to learn more about the biomes of Africa.
http://www.brookfieldzoo.org/pagegen/wok/ways_index.html

NASA—Water Witching from Space
Learn about NASA's Aqua satellite, which will provide crucial information about the water in the ground and the weather on the horizon.
http://science.nasa.gov/headlines/y2001/ast23may_1.htm

NASA—Global Hydrology and Climate Center
Check out lightning observations from space, learn about climate changes, or learn the effects of big cities on climate in this NASA sponsored web site.
http://wwwghcc.msfc.nasa.gov/ghcc_home.html

Activities and Worksheets

Going Up, Going Down

Purpose

To demonstrate the movement of warm and cool ocean currents

Background

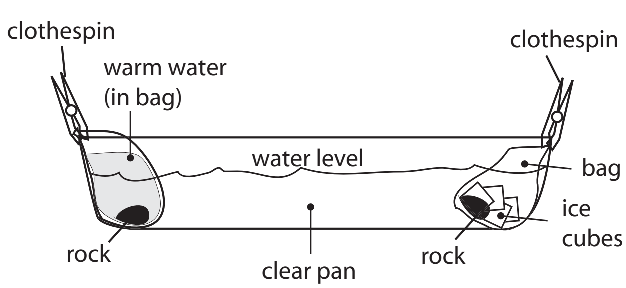
Thermohaline circulation is the name for currents that occur when colder, saltier water sinks and displaces water that is warmer and less dense. In a cycle known as the global conveyor belt, warm water from the equator flows toward the poles and begins to cool. In a few regions, such as the North Atlantic, cold, salty water can sink to the ocean floor. The water then travels in the deep ocean back towards the equator and begins to rise to replace the water that is being pushed away from the equator by normally strong winds. The cool water that rises to the surface is known as upwelling. This entire process, which may take a thousand years to complete, helps regulate the climate as heat is transported from the equator to the polar regions of the Earth. During a period of El Niño, these winds along the equator are weaker than usual and may actually blow in the opposite direction. Warm water begins to pile up along the nearby coasts. Where the ocean is warm, more clouds form and more rain falls. Weather patterns around the world are then affected by this change in ocean temperature. NASA collects satellite data to measure the sea surface and temperature and uses the data to make maps of the ocean. From these maps, scientists can monitor the speed and direction of ocean currents.

Materials

- clear glass casserole dish
- tap water
- hot water
- 2 small waterproof zipper bags
- 2 clip clothespins or small clamps
- 2 different colors of food coloring
- small rock
- 4–6 ice cubes
- science journal

Procedure

1. Fill the glass pan with tap water. Let the pan rest for a few minutes to let the water settle.
2. Place a rock in each of the plastic bags.
3. With adult supervision, fill the bag with hot water from the faucet and seal the bag.
4. Put the bag in one end of the glass pan and use the clothespin to clip the bag in place.
5. Fill the other bag with ice cubes and seal.
6. Put the ice bag in the pan opposite the warm water bag and use the other clothespin to clip the bag to the pan.
7. Carefully add four drops of food coloring to the water next to the ice cubes.
8. Now add four drops of a different food coloring to the water next to the bag of hot water.
9. Observe the food coloring for several minutes.
10. Record your observations and illustrate them in your science journal.
11. Gently blow across the top of the water surface.
12. Observe what happens and record your observations.
13. Blow across the top of the water from the other side.
14. Observe and record.



Going Up, Going Down (concluded)

Conclusion

1. Explain what happened to the water near the colder end of the pan?
2. Explain what happened to the water near the warmer end of the pan?
3. When you began to blow across the water, adding "wind power" to the water currents, how did they change?
4. What factors might change the flow of ocean currents?
5. How do changes in the ocean currents affect the Earth?

Extension

1. Locate maps of ocean currents. On a blank world map, use red- and blue-colored pencils to mark the warm and cool currents. Include arrows to show direction. Notice the difference in current flow between the northern and southern hemisphere. Why do you think this difference occurs? To demonstrate this phenomenon, go to the NASA SCI Files™ web site. From the home page, click on the tree house and then on "Dr. D's Lab." In the lab, click on the 2001–2002 season. Click on *The Case of the Phenomenal Weather* and you will find the experiment, "Round and Round We Go". This experiment will help you learn more about the Coriolis effect.
2. Examine satellite image maps of ocean temperatures and make your own edible ocean map by using colored gelatin and lemon sherbet. For directions, visit http://spaceplace.nasa.gov/topex_make2.htm
3. Measure the temperature at the surface and bottom of the warm end of the pan as you repeat steps 2-14. Record the temperature as you make changes. Explain what is happening.

Where the Water Sheds

Problem

To become familiar with watersheds and to identify the watershed that serves the local community

Materials

state road map
colored markers
Internet (optional)

Background

Each small stream can have thousands of liters of water flow through it each day, and each stream is only one part of a river system. Just as a tree is a system of stems, twigs, branches, and a trunk, a river system also has many parts. Water runs off the ground into small streams. As the small streams merge, they form a larger body of water called a river. A watershed is the land area from which surface water runoff drains into a stream, lake, reservoir, or other body of water. Watersheds are also called drainage basins. Areas of higher elevation separate watersheds from each other. The Environmental Protection Agency (EPA) and the United States Geological Survey (USGS) monitor the water quality in the watersheds.

Teacher Note

To create a set of reusable maps, laminate the maps and use washable markers. If a sufficient number of computers are not available for students to conduct the optional Internet search, then prior to conducting this activity (for 1–2 weeks) print off the data charts needed, make copies, and have students graph the data.

Procedure

1. Locate your city or town on the road map.
2. Put a box around the name of the town.
3. Find the river on the map closest to your city.
4. Use a colored marker and trace the flow of the river from its origin. If your map is not large enough to include the river's origin, use the closest state boundary.
5. Use a different color marker to highlight any small creeks or streams that feed into the river along the way.
6. Color any lakes by using a third color.
7. By looking at the map, can you tell which way the water flows?
8. With a fourth colored marker, broadly circle the area around your markings but do not cross any other streams.
9. The area inside the circle is the watershed for your local area.
10. Optional: On the Internet, open the Environmental Protection Agency (EPA) web site, Surf Your Watershed. *http://www.epa.gov/surf2*
11. Click on "Locate Your Watershed."
12. Click on "Search by Map."
13. Find your state and click on the appropriate picture.
14. On the state map, click on your specific area.
15. Find the link for "Stream Flow" and click on it.
16. In your science journal, create a chart and record the date and time, stream stage in feet (ft), and the stream flow in feet per second (ft/sec).
17. Check and record the data for several days.
18. After one week, create a graph depicting your data.
19. Graph your findings at the end of two weeks and compare graphs.

Where the Water Sheds (concluded)

Conclusion

1. Why is it important to protect the water in an entire watershed?
2. How can understanding watersheds help geologists predict where water will flow?
3. What effects do people and animals have on a watershed?
4. How could a watershed change over time?
5. Based on the data you collected about stream stage and flow, what information can you learn about your watershed?

Extensions

1. On a United States map, determine where the water from your watershed eventually ends up. Follow the path of the water downstream until you reach a gulf or ocean. Discuss how decisions made for a watershed in one area affect other parts of the country.
2. Compare the branching of your watershed to other branching networks, such as the human nervous system or the roots of a tree. How are these the same? Different?
3. Visit some of the other links on the Surf Your Watershed web site. Take the Watershed Quiz to test your knowledge about watersheds. Participate in the Watershed Patch Project *http://www.epa.gov/adopt/patch/certificates* and learn about things you can do to protect your watershed. Do a stream site survey or test a local stream for water quality.
4. Use the reference list to choose a story about a river. After you have read the story, write your own story about a river near where you live. How has the river changed over time?

A "Reservoiring" We Will Go

Purpose

- To illustrate how a reservoir works
- To build a model of a water delivery system

Materials

clear plastic box
pebbles
soil
sand
leaves
spray bottle with water
large piece of paper
2 paper towel tubes
2 toilet tissue tubes
straws
toothpicks
wooden skewers
small milk carton
scissors
glue
metric ruler
markers
tape
Optional: toy houses (game pieces)

Procedure

1. Line the bottom of the clear plastic box with small pebbles. Slope the pebbles so that they are higher on the sides (4–5 cm) and lower in the middle (1–2 cm). This middle area will become the reservoir.
2. Add a layer of sand, following the same sloping created in step 1.
3. Repeat step 2 with soil.
4. On top of the soil, place leaves around the outer edges. See diagram 1.
5. Using a spray bottle, carefully spray water on the four corners of the model until the soil mixture is saturated and the water has seeped through to the reservoir.
6. In your group, discuss how a reservoir is formed and write a brief paragraph describing the process.
7. On a flat surface, place the reservoir at one end of the large piece of paper or cardboard.
8. To create a water treatment plant, stand a small toilet tissue tube on end so as to trace its circumference on one side of the milk carton.
9. Use scissors to cut out the circle.
10. Repeat steps 8 and 9 on the opposite side of the milk carton. See diagram 2.
11. Connect the water treatment plant to the reservoir by using a small toilet tissue tube in each of the cutout holes. See diagram 3.
12. Brainstorm ideas on how a pipe system works to get water from the reservoir to the water treatment system and finally to the homes and businesses in a community. Remember that you have four different sizes of pipes to use in your pipe system.

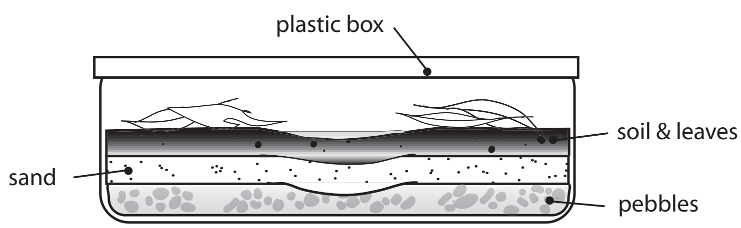


Diagram 1

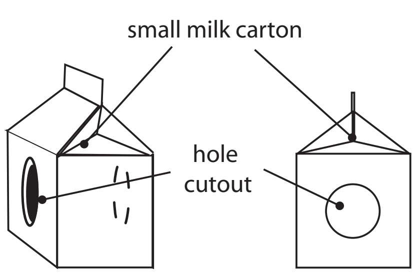
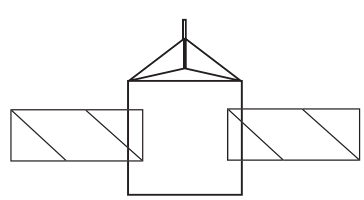


Diagram 2



milk carton with toilet tissue tubes sticking from holes

Diagram 3

A "Reservoiring" We Will Go (concluded)

13. After reaching a consensus, draw a design for your pipe system in your science journal. Be sure to consider which size "pipe" should be used for each level of the pipe system and explain why.
14. Following your design, use cardboard tubes, straws, wooden skewers, and toothpicks to create your pipe system for a community of homes. If necessary, use scissors to cut pipes to length.
15. Use glue to secure the system together and in place.
16. Connect your system to the reservoir.
17. If using game pieces for houses, place them at the end of the pipe system for each branch or draw houses and businesses on the cardboard.
18. Discuss how water gets into the reservoir and then to your house. Trace its path and record in your science journal. Illustrate the path.

Conclusion

1. What are sources of water for a reservoir?
2. How does water get into a reservoir?
3. In a real reservoir, what holds the water in?
4. In your pipe system, how did the size of the pipe get larger or smaller as it left the water treatment plant? Explain why.

Extension

Conduct research on water towers and give a report on their importance to a water system. Add a water tower to your system.

To Still Water

Purpose

To understand how salt can be removed from saltwater

Materials

clean, wide mouthed glass gallon jar with lid
small paper cup
35 mg salt
965 mL warm water
bowl
spoon

Background

Ocean water can and is being desalinated. However, turning ocean water into freshwater can be expensive, up to ten times more than the cost of obtaining water the normal ways. The most expensive process used to convert saltwater into freshwater is distillation. During distillation, the saltwater is boiled, and as the water turns into steam and evaporates, it leaves the salt behind. As the steam is cooled, it condenses into relatively pure water. Saltwater can also be frozen. After it is frozen, the salt is separated from the water and the ice melts back into freshwater. Another method is to electronically separate the salt into positive and negative ions, which are then filtered out of the water as the ions pass through microscopic holes in special plastic sheets. Algae and some kinds of bacteria are also used to biologically absorb the salt, and a final way is reverse osmosis, a mechanical process that forces saltwater through semipermeable membranes under high pressure. In this process, the freshwater is squeezed out and the salts are left behind.

Procedure

1. In a bowl, use a spoon to mix 35 mg of salt into the warm water. This mixture represents the ocean's saltwater.
2. Pour the solution into the paper cup. Do not over fill.
3. Place the jar lid upside down in full sunlight.
4. Set the cup of saltwater in the center of the large lid.
5. Place the jar carefully on the lid so the cup fits inside the jar. The jar should be level but does not need to be screwed onto the lid. See diagram 1.
6. Wait at least one hour.
7. Observe and record in your science journal what you see on the inside of the jar.
8. Carefully pick up the jar so as not to spill the saltwater.
9. Taste one of the water droplets that has fallen into the lid.

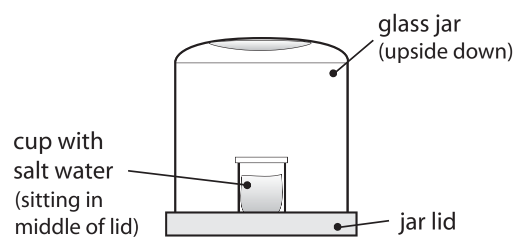


Diagram 1

Conclusion

1. What causes the water droplets to form?
2. Is the water on the inside surface of the jar fresh or salty?
3. What causes this change to happen?
4. Why can't the tree house detectives make a solar still to solve their water problem?

Extension

1. Conduct research and find other ways of removing salt from saltwater.
2. Pour saltwater through a series of coffee filters. **NOTE: DO NOT use a drip coffeemaker in this experiment, as it will ruin it**. Collect the water and filter it again. Is the water less salty than it was in the beginning? Set out the filters to dry. Examine them carefully after they have dried completely. What do you see?

One in a Million

Purpose

To understand the concept of parts per million

Background

Water often contains various substances besides the water itself. Certain minerals, such as iron, chloride, and sodium may be in tap water in different concentrations. Some substances that are found in the water may be hazardous to human or animal life. Scientists conduct tests to look closely at the substances contained in water and determine whether the concentrations of these substances are at safe levels. The amount of a substance in water is often expressed in parts per million or p/m.

Materials

7 small paper cups
metric measuring cup
metric measuring spoon
240 mL of mouthwash (choose one that is strongly colored and flavored)
1 liter (L) of tap water
cup for rinse water
marker
science journal

Procedure

1. Use a marker to label each cup 1 through 7.
2. Place 150 mL of mouthwash in cup 1.
3. Remove 15 mL of mouthwash from cup 1 and put it in cup 2.
4. Rinse the measuring spoon with tap water.
5. Now add 135 mL of tap water to cup 2.
6. Stir thoroughly.
7. Repeat steps 3–6, taking from cup 2 and putting into cup 3.
8. Observe what happens to the solution's color as the mouthwash is diluted.
9. Make a hypothesis for when (which cup) you think the solution will be a clear color and record in your science journal.
10. Repeat steps 3–6, taking from cup 3 and putting into cup 4.
11. Repeat the dilution process until you have used all 7 cups.
12. Observe and record your observations, describing the color of each solution.
13. Observe and record your observations, describing the odor of each solution.
14. To make a chart showing the concentrations of the various cups in parts per million.
    a. Use cup 1 as 100% (mouthwash), or one million parts per million.
    b. Cup 2 is a 1 to 10 or 1/10 concentration, which means there are 100,000 parts per million.
    c. Cup 3 is one-tenth (1/10) the concentration of cup 2. It is 1/100 or 10,000 parts per million.
    d. Calculate the concentration of each of the other cups.
    e. Compare these concentrations to maximum allowable levels of some common minerals in drinking water:

chloride	250 p/m
sodium	250 p/m
iron	0.30 p/m
fluoride	4.00 p/m

Conclusion

1. In which cups were you able to detect any color? Odor?
2. What is the concentration of mouthwash in the last cup?
3. Why is it important for scientists to measure the amount of a substance that is in our water?
4. Why is it important to learn about dilution and parts per million as they relate to the water cycle?
5. Is dilution an effective way to clean up pollution or to reduce harmful materials found in water? Why or why not?

One in a Million (concluded)

Extension

1. Use a pH kit to determine the pH of water samples from various sources and compare. Water that has a high percentage of dissolved mineral salts is called hard water. Hard water has a pH greater than 7. Hard water may appear perfectly clear, but the dissolved salts make it difficult to get soapsuds. The water may then leave behind a hard, crusty build-up when the water evaporates. Add dish or laundry soap to each sample. Shake well and observe how the sudsy action relates to the pH level. Record your observations.

Challenge

You have a 1-liter (L) bottle with a small amount of contaminating chemical. You want to rinse out the bottle and you only have 1 L of clean water. Should you pour in all the water at once and dump it out? Should you pour in a small portion of the water and dump it out, repeating the process several times? Choose one and explain your choice.

Answer Key

Going Up, Going Down

1. The water at the cold end of the pan sinks to the bottom and begins moving across the pan towards the warmer end.
2. The water at the warmer end of the pan immediately rises to the top and begins traveling across the top of the water toward the cooler end.
3. By blowing on the water, you caused the warm water to cool faster. It began to sink below the surface. The wind you created also helped push the water along.
4. Temperature and winds are important factors for ocean currents.
5. Ocean temperatures affect the temperature of nearby landmasses and the amounts of rainfall that can be expected over the land.

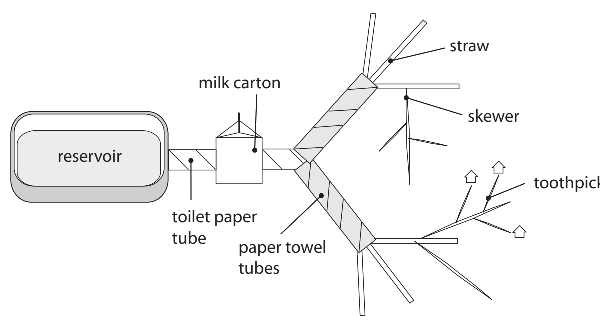
Which Watershed Are You In?

Note: *Students should be able to determine the direction of flow of the river in their watershed by knowing that smaller streams flow into larger streams.*

1. Answers will vary but should include that although areas of higher elevation may separate watersheds, all watersheds eventually drain into waterways that connect and drain into the oceans of the world. Pollutants in any of these waterways are then carried with the water to the ocean.
2. There are many benefits to understanding the flow of water in a watershed. For example, scientists can learn about water flow by studying the shape of the landscape and the stream flow amounts where the watershed drains. They can use this information to help control floodwaters and store water in reservoirs.
3. The effects are many, but answers should include that people and animals may change the face of the land, causing water flow to change. They may also introduce pollutants that can travel through a watershed.
4. Answers may vary but should include that mountains and hills may erode over time, changing the path along which the water flows.
5. Information will vary.

A "Reservoiring" We Will Go

1. The sources of water for a reservoir are any forms of precipitation such as rain, snow, sleet, hail, and so on.
2. Water gets into a reservoir by precipitation and by seeping over and through the soil above a reservoir.
3. In a real reservoir, a dam holds the water in.
4. The circumference of the pipes decreases as the distribution system expands into the community. As water travels through the pipe system, it is continuously diverted down different pathways leading to individual homes and businesses. The circumference of the pipe determines the amount of water that can be contained in the pipe at any one time and also determines the rate at which the water will travel through the pipes. The amount of water needed by an individual home or business is much smaller than the amount that left the treatment plant. Therefore, smaller pipes are needed the farther away you go from the treatment plant.



To Still Saltwater

1. Water inside the jar heats and begins to evaporate. As the water vapor rises, it is trapped against the jar and begins to cool, condensing into water droplets. The droplets run down the sides of the jar, collecting in the lid at the bottom.
2. The water is fresh.
3. When the water evaporates, the salt is left behind.
4. The solar still is an inefficient way to distill water. The still would have to be very large to create enough water to wash even one car.

Answer Key (concluded)

One in a Million

1. Depending on the original color of the mouthwash, the color should disappear by the third or fourth dilution. Odor will remain longer.
2. The dilution is one part to a million.
3. Some substances can be harmful to living things. Scientists can monitor these harmful substances to determine what concentrations are safe for human and animal use.
4. As hydrologists monitor water flow, they may also check for substances that are dissolved in the water. These substances may be natural or man-made and may be introduced into the water cycle as ground pollutants or acid rain.
5. Answers will vary.

On the Web

To Orbit or Not To Orbit, That Is the Question

1. The marble rolled around the inside of the cone. Its path began to curve downward as the speed of the marble became faster until the marble finally reached the bottom of the cone and stopped.
2. The conical shape of the poster board forced the marble into a circular path and gravity pulled the marble downward. As friction decreased the forward speed of the marble, the unchanging pull of gravity forced it to move down the cone toward the bottom.
3. The speed of the marble did not affect its "path." The marble eventually fell to the bottom of the cone because gravity won out as the speed of the marble decreased. However, the speed of the marble did affect the initial start point (higher) and the amount of time that it took for the marble to fall. The greater the speed, the more momentum the marble had, and the longer it took to overcome gravity. However, if the marble had gone too fast, it would have flown out.

Stationary Stations

1. The person on the outside had to move faster than the person on the inside so that both people would stay in line with each other.
2. The distance around the outside path (circle) around the tree is larger than the path (circle) near the tree. A person must walk at a faster speed to travel around the larger circle at the same time that the person travels around the smaller circle. Geostationary satellites travel at very fast speeds to give them orbital periods of 24 hours to match the rotation of specific positions on Earth; thus, the satellites appear to remain stationary.
3. Answers will vary but might include that geostationary satellites make it possible for weather satellites to constantly monitor the weather of a region. They also enable television satellite dishes to receive a constant signal so that programming is uninterrupted.
4. Due to a limited amount of "space" directly above the equator, it is possible to have too many satellites. If it gets too crowded, the various satellite signals might begin to interfere with each other.

Move Over. You're in My Way

1. Light waves travel in a straight line. When the light hit the mirror, it bounced off in a straight line, but at an angle. The mirror had to be adjusted away from the can so that the angle of the light's reflection could shine on the flap of paper. As the mirror moved, the angle of reflection stayed the same, but the beam's position shifted towards the other side of the can.
2. If the satellite is placed too close to Earth, its signal will not travel very far due to the curve of the Earth's surface. The movement of the light from one side of the can to the other is similar to the transmission of radio waves around the Earth via satellites. A communication satellite in orbit above the Earth's equator transmits radio signals from one place on the Earth to a receiver on the opposite side. If the satellite were not placed correctly, the reflection would not be in a position high enough to send the radio waves to the receiver.